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Several approaches have been identified which have the potential to significantly reduce annual fuel consumption. The approaches are an information program to allow consumer selection of fuel-efficient tires and incorporation of tire inflation pressure maintenance in existing or planned inspection programs. A tire information program has the potential to reduce fuel consumption by 3 billion gallons annually. An annual inflation inspection and maintenance program could be expected to save approximately 300 million gallons. A consumer information program on the fuel economy aspects of tire inflation pressures could also be cost effective. The report discusses these several approaches to save several billion gallons of gasoline annually.

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Technical Report

Tire Programs

Several Approaches with Significant Potential to Decrease Fuel Consumption

by

Glenn Thompson

June 1979

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Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise and Radiation
U.S. Environmental Protection Agency

Abstract

Tires have a significant effect on the fuel economy of a vehicle because of the energy which they dissipate during use of the vehicle. Consequently, any approaches which reduce the energy dissipated by tires will improve vehicle fuel economy and will reduce the national fuel consumption. Tire-related approaches to reduce U.S. annual fuel consumption have several potential advantages; primarily the rapid replacement rate of tires, at least compared with the vehicle population, and the universal applicability of improved tire technology to all light-duty vehicles and small trucks.

Several approaches have been identified which have the potential to significantly reduce annual fuel consumption. The approaches are an information program to allow consumer selection of fuel-efficient tires and incorporation of tire inflation pressure maintenance in existing or planned inspection programs. Both of these potential programs are technologically feasible at the present time.

A tire information program has the potential to reduce fuel consumption by 3 billion gallons annually. It is very difficult to predict the success of such a program, however, with 10 percent efficiency 300 million gallons would be conserved. Even if the program were only 1 percent efficient, the resulting fuel conservation of 3 million gallons would probably offset the cost of the program.

An annual inflation inspection and maintenance program could be expected to save approximately 300 million gallons. Such a program would certainly seem to be cost effective when incorporated into any existing or planned safety or emissions inspection program.

A consumer information program on the fuel economy aspects of tire inflation pressures could also be cost effective. However, the cost effectiveness of this approach would result more from the low cost of the approach than the amount of fuel saved.

Introduction

Tires have a significant effect on the fuel economy of a vehicle because of the energy which they dissipate during use of the vehicle. Consequently, any approaches which reduce the energy dissipated by tires will improve vehicle fuel economy and will reduce the national fuel consumption. Tire related approachs to reduce U.S. annual fuel consumption have several potential advantages; primarily the rapid replacement rate of tires at least compared with the vehicle population, and the universal applicability of improved tire technology to all light-duty vehicles and small trucks. This report discusses several approaches to reduce tire energy dissipation which have the potential to save several billion gallons of gasoline annually.

Discussion

EPA reports and other literature have investigated the energy dissipation characteristics of tires.(1,2,3) From these investigations the following aspects of tire or tire use have been identified as major parameters affecting the tire energy dissipation:

1. Construction.
2. Inflation Pressure.
3. Temperature.
4. Vertical Load.

Tire construction, as used in the above Table, includes all aspects of the tire which are determined during manufacture. For example, the choice of components such as cord type and rubber compounding are included as well as the type of construction, such as radial or bias ply. The tire inflation pressure is, obviously, the cold inflation pressure of the tire. This parameter is most noteworthy because it is determined by the vehicle operator, presumably by following the recommendations of the tire or vehicle manufacturer. The tire temperature is primarily dependent on the ambient temperature which cannot be controlled and on the length of the vehicle trip. The tire temperature is also somewhat dependent on the tire and rim heat dissipation characteristics. The vertical load is the weight supported by the tire and is primarily determined by weight of the vehicle.

Considering the above definitions of the parameters affecting tire energy dissipation, only the first two, the tire construction and the inflation pressure, are directly tire or tire-use related. The remaining parameters are predominantly vehicle related. Consequently, since this report addresses tire approaches to

reducing fuel consumption, and since vehicle-use parameters have already been discussed by other literature, only the direct tire parameters of construction and inflation will be discussed further in the subsequent sections.(4)

A. Tire Construction

The best known example where tire construction affects the fuel economy of a vehicle is the fuel efficiency of the radial tire versus that of the bias-belted or bias-ply tire. However, data are also available to indicate the effects of such parameters as the tire cord material.(5)

The magnitude of the potential effects of tire construction can be seen from the estimation that if all current non-radials were replaced, when worn, with radial tires, the U.S. fuel consumption could be decreased by approximately 2 percent.(6) This represents about 1.4 billion gallons in the case of passenger cars and about 2 billion gallons if light-duty trucks are included. In addition, if optimum radial tires were selected in each case even greater fuel savings are possible. Assuming consistent selection of optimum tires, the U.S. annual fuel consumption could probably be decreased by an additional billion gallons. It is also possible that if optimal tire selection occurred consistently during vehicle use, the vehicle manufacturer would have increased willingness to reduce engine size, since any resulting reduction in performance would be minimized. This synergetic action would further increase the potential for reduction in fuel consumption.

One major problem in the selection of optimum tires is the inability of a consumer to choose such tires. At the present time, no consistent tire grading information or labeling program for tire energy dissipation exists. Therefore, a consumer or a fleet owner does not have sufficient information to choose fuel efficient tires if so desired. Also, since this information is not available in the marketplace, there is little pressure for the tire manufacturer to develop fuel efficient tires for aftermarket sales. However, aftermarket sales must be considered important in any fuel conservation strategy since 70 percent of all tires are sold as replacement tires.(7)

EPA experience in the vehicle fuel economy labeling system indicates that a tire labeling system could be an effective approach to reduce U.S. fuel consumption. In the vehicle labeling program about 50 percent of the new vehicle purchasers are aware of the EPA-DOT vehicle fuel economy labels or the Buyer's Guide. Of those that are aware of the labeling system, the vehicles they purchase are approximately 20 percent more fuel efficient than their previously owned vehicle. In comparison, for that segment of the population unaware of the labeling program there is no statistically significant difference between the fuel economy of the

new vehicle they purchased versus their previous vehicle.(8) This indicates that a significant segment of the population is interested in fuel efficient vehicles and apparently the vehicle fuel economy labeling system is assisting these people in their vehicle selection.

It is reasonable to believe that the fuel conservationist segment of the general population would also be interested in fuel efficient tires. However, in this instance no information is available to enable the consumer to purchase optimum tires. Since the consumer action of purchasing tires is socially different from that of purchasing a new vehicle, it is very difficult to predict the extent of the population which would be influenced by a tire information program. However, if this conservation program were 10 percent efficient, that is, only 10 percent of the total potential of 3 billion gallons were conserved, this conservation of 300 million gallons is significant and approaches a savings of a million gallons per day. Even if the program were only 1 percent efficient, the resulting fuel conservation of 3 million gallons would probably offset the national cost of the program.

B. Inflation Pressure

Tire inflation pressure is a very significant parameter affecting the fuel economy of a vehicle. For example, an 8 psi increase in tire inflation pressure would improve the fuel economy of the current average vehicle by about one mile per gallon. If all vehicle tire inflation pressures were increased by this amount, the national fuel savings would be about 4 billion gallons. With existing tires, this great an increase in inflation pressure would cause an increase in ride harshness which would be objectionable to some vehicle owners. However, it should be noted that the tires in use are typically underinflated by 3 to 4 psi.(9) Correction of this underinflation should not result in unacceptable ride characteristics and could yield a fuel conservation of 2 billion gallons.

Tire inflation pressure is an unusual parameter because it is controlled by the vehicle operator. Consequently, if the vehicle owner could be pursuaded to better maintain his tire inflation pressure an immediate fuel conservation would be realized for all vehicles in service. Conversely, it will be very difficult to change the vehicle maintenance habits of a significant percentage of such a large diverse group as all vehicle owners.

Several approaches to improve maintenance of tire inflation pressures are probably worthwhile. First, a press release followed by a small information program conducted in cooperation with any interested automobile magazines would reach a large segment of the automobile enthusiasts at little expense. Such a program could logically be conducted in cooperation with DOT and/or DOE with EPA

providing the experimental design and measurement expertise. If industry participation is also desired, cooperation could be solicited via TRA, API, MVMA or other manufacturers associations.

A second approach would be to incorporate a tire inflation check in any safety or emissions inspection program. To ensure the effectiveness of any such inflation check, the program should include increasing the tire inflation to the recommended values if additional air is required. Prior to implementing such a program some experimental effort might be required to determine appropriate pressure correction factors to enable estimation of the cold inflation pressure from the observed inflation pressure as a function of the tire and ambient temperatures. This would probably be required since vehicles encountered in inspection program often will have been operated prior to the inspection and therefore would not have cold tires. Such correction factors would allow prediction, using the tire temperature, of the necessary tire inflation pressure in the as received condition to produce the recommended cold inflation pressure.

If an inflation check were conducted once a year, then all vehicles would presumably have correctly inflated tires for a minimum of one month of the year, and probably for at least two months. Therefore, this inflation check can be expected to save at least one-twelth to one-sixth of savings associated with underinflation or about 300 million gallons. These savings should more than offset the small incremental cost of performing the inflation check as part of any existing inspection program.

C. Relationship of the Proposed Tire Programs to Current EPA-DOT Fuel Conservation Programs

Reduction of vehicle fuel consumption by increasing tire inflation pressures does not require technological innovation. Automobile manufacturers are currently receiving a benefit for increased tire inflation pressures in the EPA-DOT fuel economy programs. Consequently, recommended tire inflation pressures are now increasing and an average recommended inflation pressure of 35 psi is anticipated in the early 1980's. The proposed tire pressure inspection and maintenance program would help ensure that these increased recommended inflation pressures would also provide fuel conservation for vehicles in consumer use.

Fuel conservation from selection of low energy dissipation tires is also currently practiced by vehicle manufacturers in the EPA-DOT fuel conservation programs. Consequently, EPA has already proposed test techniques for determining tire energy dissipation in a manner representative of typical tire use.(10) A tire energy dissipation information program is also technologically feasible using the same test methods. Such a program could simply classify

tires in several energy dissipation categories; for example, class a, b, c, and d tires. An alternate approach would be to present estimated comparative tire operating costs in dollars per thousand miles. The necessary information to convert from tire energy dissipation to estimates of average tire operating costs is already available from the EPA-DOT fuel economy programs. This approach of presenting estimated operating costs, perhaps in pamphlet or other form, is considered superior to an energy dissipation ranking system because it would be conceptually obvious for the average consumer. In addition, by comparing the operating costs, the anticipated tire mileages and the purchase price of tires, a consumer could, if desired, select tires which would provide the lowest total cost per mile of vehicle operation.

There is no question of the technological feasibility of either of the proposed programs which simply try to provide the vehicle consumer with sufficient information and encouragement to maintain the vehicle in as efficient condition as when it was manufactured. In the absence of some programs of this nature, the discrepancies between the measured fuel economies and the average in-use vehicle fuel economy must be expected to increase.

Conclusions

Consumer choices of optimum tires and maintenance of recommended tire inflation pressures each have the total potential to reduce annual U.S. fuel consumption by approximately 3 billion gallons.

It is difficult to predict, however, the percentage of this total potential which might be obtained by government programs. Even if only 10 percent of the total potential could be obtained from a tire labeling and information program, this would be 300 million gallons annually. With this savings such a program could be cost effective and should be investigated further.

If all tires were maintained to the inflation pressure recommended by the vehicle manufacturer, U.S. annual fuel consumption could presently be reduced by about 2 billion gallons. This potential savings is anticipated to increase as recommended tire inflation increases in future years, since actual in-use pressures are not anticipated to increase as rapidly as are the recommended pressures.

An annual inflation inspection and maintenance program could be expected to save approximately 300 million gallons. Such a program would certainly seem to be cost effective when incorporated into any existing safety or emissions inspection program.

A consumer information program on the fuel economy aspects of tire inflation pressures could be effective. However, the effec-

tiveness of this approach would result more from the low cost of the approach than the amount of fuel saved. A significant advantage of such a program is that it could be developed in an extremely short time period.

All of the above approaches are technically feasible and do not require any technological innovations. These programs would help to ensure that some of the fuel economy improvements for which manufacturers have received benefit in the EPA-DOT vehicle programs would retain their efficiency throughout the useful life of the vehicle. Consequently, these programs would help to reduce the observed discrepancies between EPA fuel economy measurements and the fuel economies achieved by consumer vehicles.

References

1. G. D. Thompson and M. Torres, "Variations in Tire Rolling Resistance - A Real World Information Need," Proceedings of the 1977 SAE-DOT Conference, Tire Rolling Losses and Fuel Economy - An R and D Planning Workshop.

2. J. D. Walter and F. S. Conant, "Energy Losses in Tires," Tire Science and Technology, TSTCA Vol. 2, No. 4, November, 1974.

3. S. K. Clark, R. N. Dodge, "A Handbook for the Rolling Resistance of Pneumatic Tires," Final Report No. DOT-TSE-78-7 prepared for the Department of Transporation.

4. J. D. Murrell, "Light-Duty Automotive Fuel Economy ... Trends Through 1978," Society of Automotive Engineers, Paper No. 780036.

5. F. J. Hunter (DuPont of Canada, Limited) letter to C. L. Gray (EPA) February 13, 1976.

6. G. D. Thompson, "Fuel Economy Effects of Tires," EPA Technical Report, February, 1978.

7. S. LaFerre (Editor), "Tire Industry Analysis," Modern Tire Dealer, January, 1978.

8. V. A. Scardino, J. C. Birch, K. Vitale, "Impact of the FEA/EPA Fuel Economy Informatin Program," Vol. 1, Executive Summary prepared for the Federal Energy Administration by Abt Associates, Inc., Cambridge, Massachusetts 1976.

9. O. J. Viergutz, H. G. Wakely, L. Dowers "Automobile In-Use Tire Inflation Survey," Society of Automotive Engineers, Paper No. 780256.

10. G. D. Thompson, R. N. Burgeson, "Determination of Tire Energy Dissipation - Analysis and Recommended Practice," EPA Technical Report, April, 1978.